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1.	Your Reference	P58877V-GB
2.	Patent Application number *(The Patent Office will fill in this part)*	15 AUG 2003 0319171.5
3.	Full name, address and postcode of the or each applicant *(underline all surnames)*	The BOC Group plc Chertsey Road Windlesham Surrey GU20 6HJ
	Patents ADP Number *(if you know it)*	8845 27002
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom
4.	Title of the invention	Purifier/Getter for Vacuum and UHP Gas Applications
5.	Name of your agent *(if you have one)*	FRY HEATH & SPENCE LLP
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	The Gables Massetts Road Horley Surrey RH6 7DQ United Kingdom
	Patents ADP Number *(if you know it)*	~~05880273001~~ 8459554001

		Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or each of these earlier applications and *(if you know it)* the or each application number.			

		Number of earlier application	Date of filing *(day / month / year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application.		

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* — Yes

a) *any applicant named in part 3 is not an inventor; or*
b) *there is an inventor who is not named as an*
c) *applicant, or*
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(See note (d))

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Continuation sheets of this form	0
Description	8
Claim(s)	2
Abstract	1
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Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
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Request for substantive examination *(Patents form 10/77)*	0
Any other documents *(please specify)*	0

11. I/We request the grant of a patent on the basis of this application.

Signature VJ Townsend

Date 15 August 2003

12. Name and daytime telephone number of person to contact in the United Kingdom: Victoria J Townsend - 01293 776880

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PURIFIER/GETTER FOR VACUUM AND UHP GAS APPLICATIONS

This invention relates to purifiers also known as "getters" often used in gas processing applications to remove low levels of impurity or low partial pressures of contaminate species from a buffer gas. Such devices are commonly used in the manufacture of semi-conductors to maintain a clean environment in which to manufacture the product.

Semi-conductor device manufacturing methods commonly result in a toxic waste gas stream from an evacuated chamber in which the processing takes place. The waste gas stream is evacuated from the chamber by means of one or more vacuum pumps but the gas stream must generally thereafter be treated to reduce or eliminate the toxicity associated with the component species in the stream.

Semi-conductor processing involving ion-implantation is commonly employed and utilises hazardous species including phosphine (PH_3), arsine (AsH_3) and boron trifluoride (BF_3). Such an implantation method may use a secondary vacuum pump, for example a cryopump or a turbomolecular pump, to create a working pressure in the chamber of about 1×10^{-4} to 1×10^{-5} mbar; a primary pump is usually employed to back the secondary pump down to less than 1 mbar.

It is also well known to employ purifiers comprising a chemically active "getter" material which forms stable compounds with the species being pumped, thereby removing contaminate or dangerous species. Such purifiers have hitherto been commonly used in sorption pumps.

The most common getter material is titanium which may be activated to provide a clean, active surface for reaction with the gas species; this can be effected by sublimation of the titanium by heating (for example resistance heating) to form a vapour of the titanium and the

subsequent formation of the deposited "active" titanium surface by condensation of the titanium vapour.

Within UHP (ultra high purity) gas processing applications purifiers such as those previously described are often used to remove low levels of impurity, for example below 10's ppm, from the process environment. In certain vacuum processing applications these purifiers are also used to remove low partial pressures, for example below 10^{-2} Mb, of contaminate species e.g PVD (physical vapour deposition) in semiconductor processing. However, the problem with this approach is that the purifier has a finite capacity and while the units are sized to give an acceptable lifetime under normal operation, during fault conditions they may rapidly reach this limit and cease operation. In addition, such purifiers have a relatively low capacity to size ratio i.e. to achieve a high capacity (long life) a large getter / purifier is needed.

In addition there are certain UHP gas and vacuum processing applications which generate exhaust streams comprising of an inert buffer gas with low levels of active contaminates e.g. Xe in EUV (extreme ultra violet) sources, Ar in PVD applications and N_2 / Ar in ALCVD (atomic layer chemical vapour deposition) applications. In these applications the gas is often vented to the house scrubber or a POU (point of use) exhaust system.

The invention relates to a renewable getter / purifier which gives a high capacity in a compact assembly, which can tolerate fault conditions and which has application in a wide range of gas processing applications.

In accordance with the invention, there is provided a purifier for use in gas processing applications, comprising:

a chamber having a gas inlet and a gas outlet,

a series of baffles arranged in the chamber and a source composed of a getter material also arranged in the chamber, the

getter material being selected for its ability to react with species to be removed from a gas stream and form stable compounds.

In use the getter material source is treated so as to produce, an electric evaporation of the getter material, for example, by an electric arc struck within the chamber causing arc evaporation, which then coats the series of baffles. The gas to be purified (the buffer gas) enters the chamber and flows over the baffles which are coated with an active layer of the getter material. The contaminate species are selectively removed by reaction with the getter material to form stable compounds. The inert buffer gas does not react with the getter material and so is simply cleansed of contaminate species as it passes through the purifier.

If the buffer gas is a noble gas then very reactive getter materials can be used e.g. Ti, Ta, Zr and alloys thereof, however if the buffer gas is more reactive e.g. N_2 then other materials which do not react with N_2 need to be used such as Fe, Cr and alloys thereof. In addition, the getter material may be further selected to maximise the pumping/capture of particular contaminant species.

Once the active layer of getter material has formed a stable compound with the contaminate species on the surface of the baffles and is saturated, a new layer of active material can be deposited simply by evaporating more getter material (for example by striking another arc in the chamber). The new active layer sits on top of the layer of stable compound thereby permanently removing it from the gas wetted parts of the system.

Renewal of the active layer could be triggered manually or, more conveniently automatically, for example by a time event or by a suitable sensor either within the chamber or at the outlet of the chamber.

The arrangement of baffles is desirably configured so as to provide a convoluted path through which the gas must pass, such that there is

available as great a surface area as possible of active material with which contaminate species within the buffer gas may react. By careful manipulation of the baffle arrangement, any short cuts in the gas path are minimised thereby encouraging the gas to take the most convoluted route through the device. The surface area and baffle geometry required for optimum purification will depend on pressure and gas throughput.

The invention is particularly advantageous in that it permits the generation of a fresh film of active getter material *in situ*. This avoids the need for interrupting the manufacturing process to take a spent purifier off-line for regeneration or replacement of the active getter material as is necessary with purifiers known from the prior art.

A useful application of the invention is to condition exhaust gases exiting a process chamber used for the manufacture of semi-conductor products before these gases enter a vacuum pump used to maintain the desired process environment pressure. The invention may also be applied to remove hydrocarbon impurities from a Xenon recirculation system.

A specific basis of the invention is that it has been surprisingly discovered that these purifiers can be used to good effect to treat semi-conductor waste species, for example by disassociation or other reaction, and to be entrapped in the deposited material.

The purifier of the invention will therefore allow the active getter material created therein to disassociate (or otherwise ionise) the species being pumped from the semi-conductor process and thereafter to react it and cause its entrapment in the deposition material. This is generally achieved in a much more efficient manner than with known purification systems.

The getter material is preferably titanium. However, other getter materials including chromium and/or iron may be used.

In preferred embodiments, the getter material source is a rod (or rods) of the material which is surrounded by a collector, for example of cylindrical shape and made of metal which is inert in the gaseous environment to be purified, on to the (or an) inner surface of which the getter material can be deposited from the source.

In such embodiments, an electric potential is maintained between the source of getter material and the collector so that a metallic plasma is formed. This will generally require an initial high electric potential to form the plasma but a much lower electric potential thereafter. In particular, it is advantageous for there to be created a thermal equilibrium plasma which is maintained at high temperatures. As such, the vaporisation of the getter material is generally effected by arc means.

The electric potential may be continuous or pulsed. Relatively low values may be used, for example 100 volts after steady state plasma conditions have been effected.

The purifier may be embodied in a sorption pump, such a pump comprises a vacuum tight pumping envelope (or housing) having an inlet and outlet, a getter material source located in the envelope and a getter surface on the interior of the collector.

For a better understanding of the invention, reference will now be made, by way of exemplification only, to the accompanying drawings, in which:

Figure 1 shows a purifier in accordance with the invention.

Figure 2 shows a schematic representation of a semi-conductor processing system incorporating a sorption pumping the exhaust together with an in-line gas purifier device incorporating the purifier of the invention, and

Figure 3 shows an enlarged sectional view through the sorption pump shown in Figure 2.

Figure 1 shows in a partially transparent, perspective view of a purifier according to the invention generally designated 20. The purifier 20 comprises a chamber 21 and an electrode 22 extending longitudinally through the chamber 21. The electrode 22 comprises a specifically selected getter material capable of reacting with contaminate species in a gas to be passed through the chamber 21. Arranged about the electrode 22 and along the length of the chamber 21 is a plurality of horse-shoe shaped baffle plates 23a, 23b, 23c, 23d. As can be seen, the baffle plates 23a, 23b, 23c, 23d are shaped and arranged so as to provide a convoluted path C_b, C_s, C_{an} through which gas passing through the purifier 20 is forced to flow.

In use, an electric arc is applied across the chamber 21 causing arc evaporation of the electrode material. The evaporated electrode material forms a coat 24 on the surfaces of the baffles 23a, 23b, 23c, 23d and the inner wall of the chamber 21. Once deposition of the electrode material 24 is complete, the gas to be purified is passed through the chamber 21. As the gas passes over the coated baffles 23a, 23b, 23c, 23d, active (eg. contaminate) species are removed by reaction with the coated electrode material 24. The buffer gas does not react and emerges from the chamber 21 substantially free of contaminates.

When required, another electric arc is struck across the chamber 22, additional electrode material is released and coats the baffles 23a, 23b, 23c, 23d an inner wall of the chamber 21, encasing the reaction products already present on the surface of the existing layer of coated material and providing a fresh active layer of getter material for cleaning further streams of gas.

Figure 2 shows a semi-conductor processing system comprising a process tool chamber generally indicated at 1 in which semi-conductor

devices (chips) can be manufactured under vacuum conditions with process gas inlets 11 and a primary vacuum pump 2 for pumping the chamber 1; positioned between a process gas supply 12 and the process gas inlets 11 is a first purifier 13 of the invention which acts as a renewable getter. Positioned between the chamber 1 and the primary pump 2 is a second purifier 3 of the invention (a getter/purifier) acting as a secondary vacuum or sorption pump.

The getter/purifier 3 is shown in enlarged form in Figure 3. The getter/purifier 3 comprises a cylindrical housing 4, a top plate 5 and a bottom plate 6 securely attached to the housing 4, inlets 7 in the top plate 5 connected to the chamber 1 and an outlet 8 in the bottom plate 6 connected to the primary pump 2.

Also positioned in the bottom plate 6 is a source of titanium getter material in the form of a rod 9 with means 10 to apply an electric potential between the rod 9 and the housing 4.

All the components of the getter/purifier 3 are sealed to form a vacuum-tight environment within the pump.

In use of the purifier/pump within the system shown in Figure 2, an exhaust gas stream is evacuated from the chamber 1 primarily by means of the primary pump 2. With vacuum conditions inside the getter/purifier 3, an electric potential is effected between the titanium source 9 and the housing 4 so that an arc plasma discharge is introduced in to the housing 4 (as shown by the arrows) such that molecules/atoms of the species in the exhaust gas stream from the chamber 1 may be broken down and/or ionised and thereby caused to react more readily with the titanium vapour present in the housing.

A deposition 11 of titanium and titanium compounds formed by reaction between the titanium and the exhaust gas species takes place on the internal surface of the housing 4 as shown in Figure 3.

The getter/purifier may be used to good effect to pump phosphine, arsine and boron trifluoride species.

In an alternative embodiment to that shown in Figures 2 and 3, the primary pump 2 is employed to pump down the semi-conductor chamber 1 but is thereafter disconnected from the system (by valving) and the getter/purifier 3 is then connected to the chamber 1 (again by valving) with the outlet either being absent or sealed. In this embodiment, the getter/purifier 3 operates to pump the semi-conductor species without the assistance of a primary pump 2 and can generally pump large quantities of such species by means of the greater pumping efficiencies afforded by the purifiers of the invention.

CLAIMS

1. A purifier for use in gas processing applications, comprising:
a chamber having a gas inlet and a gas outlet,
a series of baffles arranged in the chamber and a source composed of a getter material also arranged in the chamber, the getter material being selected for its ability to react with species to be removed from a gas stream and form stable compounds.

2. A purifier as claimed in claim 1 further comprising means to vaporise and ionise the getter material.

3. A purifier as claimed in claim 2 wherein the means to vaporise comprises an electric arc producing device.

4. A purifier as claimed in any preceding claim wherein the baffles are configured and/or arranged so as to create a convoluted path through which a gas to be purified may flow.

5. A purifier as claimed in any preceding claim wherein the getter material is selected from; Ti, Ta or Zr or alloys thereof.

6. A purifier as claimed in any of claims 1 to 4 wherein the getter material is selected from; Fe and Cr or alloys thereof.

7. A purifier as claimed in any of claims 2 to 6 further comprising means for controlling the activation of the means to vaporise and ionise the getter material.

8. A purifier as claimed in claim 7 wherein the controller is configured to activate the means to vaporise and ionise the getter material at predefined time intervals.

9. A purifier as claimed in claim 7 wherein the controller includes one or more sensors for monitoring the environment within or outside of the chamber and is configured to activate the means to vaporise and ionise the getter material when a predefined change in the monitored environment is detected.

10. A purifier as claimed in claim 9 wherein the one or more sensors are arranged inside the chamber.

11. A pump including a purifier as claimed in any preceding claim.

12. A pump as claimed in claim 11 wherein the pump is a sorption pump.

13. A purifier substantially as described herein and with reference to the accompanying Figures.

14. A pump substantially as described herein and with reference to the accompanying Figures.

ABSTRACT

PURIFIER/GETTER FOR VACUUM AND UHP GAS APPLICATIONS

The purifier 20 of the invention comprises a chamber 21 and an electrode 22 extending longitudinally through the chamber 21. The electrode 22 comprises a specifically selected getter material capable of reacting with contaminate species in a gas to be passed through the chamber 21. Arranged about the electrode 22 and along the length of the chamber 21 is a plurality of horse-shoe shaped baffle plates 23a, 23b, 23c, 23d. As can be seen, the baffle plates 23a, 23b, 23c, 23d are shaped and arranged so as to provide a convoluted path C_b, C_s, C_{an} through which gas passing through the purifier 20 is forced to flow.

[Fig. 1]

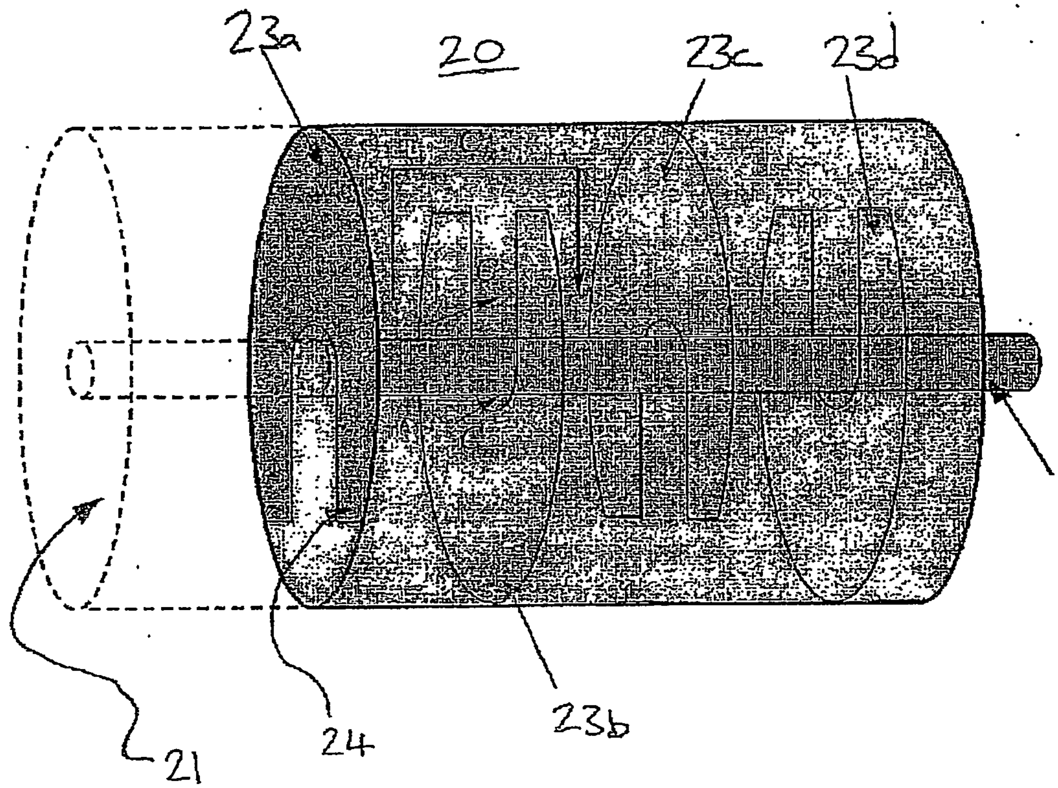

FIG. 1

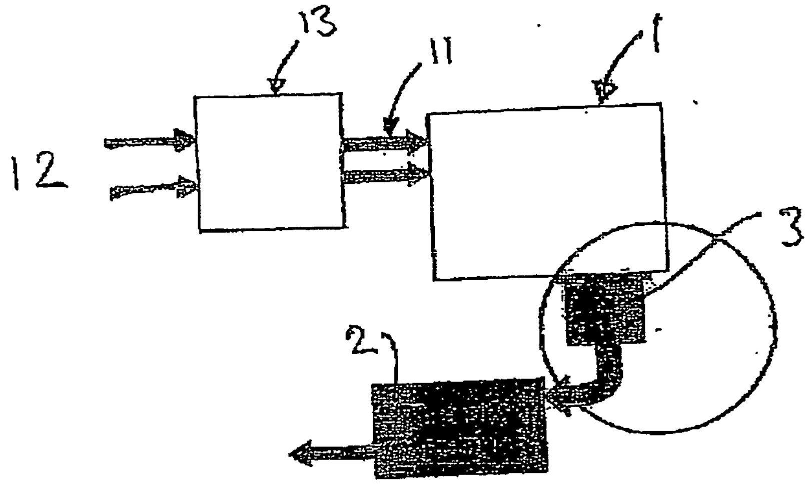

FIG. 2

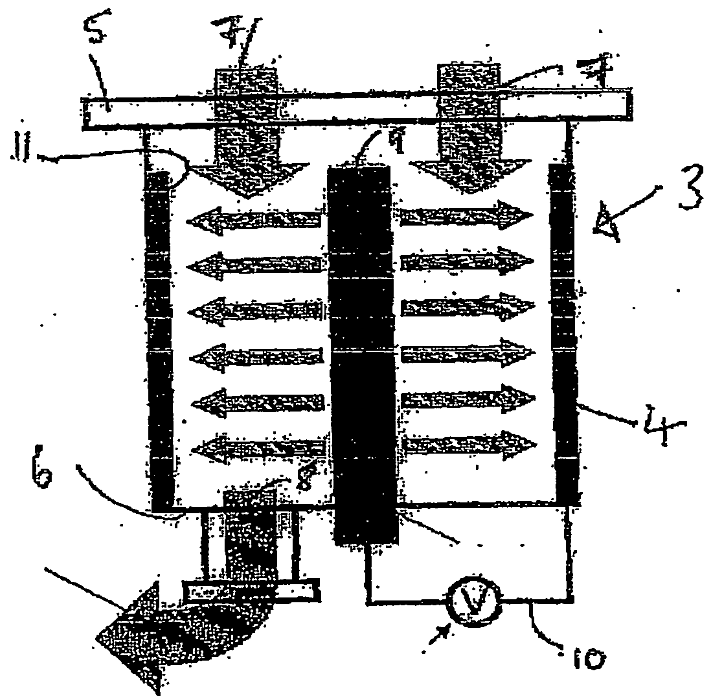

FIG. 3